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A SEALED PAPER CARTON TO PROTECT CEREALS FROM INSECT ATTACK.

By William B. Parker, *Entomological Assistant.*

ECONOMIC IMPORTANCE OF THE PROBLEM.

During an investigation of the insects attacking dried fruits at Sacramento, Cal., during 1912, the infested condition of packed cereals was brought to the writer's attention. The economic importance of these infestations is greater than at first appears. The purchaser usually returns infested packages to the grocer. The grocer returns them to the mill where they were prepared. The mill screens the cereal and sells it as feed. Thus the condition of the cereal itself is the cause of a disagreeable feeling on the part of the consumer and occasions a loss of time to the grocer and a considerable loss financially to the miller.

Besides this intrinsic loss, the consumer may demand of the grocer another "brand" in the hope of finding a cereal which is not infested by insects, or, by jumping to the sudden conclusion that all cereals are infested during the summer, may forego the use of breakfast foods for a time. The exact financial loss due to these conditions can not be accurately determined, but extensive observations lead to the belief that it is much greater than most millers suppose.

PRELIMINARY OBSERVATIONS.

Examinations of infested packages taken in grocery stores, warehouses, and mills showed that the majority of infestations commenced at the ends of these packages, or where a small hole had been broken in the edge, due to rough handling. The cereal in these packages was sterilized prior to being packed, so that the insects which caused the infestation must have deposited their eggs after, or shortly before, the cereal was packed. The presence of the confused flour beetle (*Tribolium confusum* Duv.) inside of the ends and the presence

of small openings at the corners of many packages led to the conclusion that if cereals were run directly from the sterilizer into cartons, which in turn were properly sealed, infestation would not in most cases take place. This theory was strengthened by statements from grocers to the effect that certain packages which were carefully sealed were not returned to them because of the presence of insects.

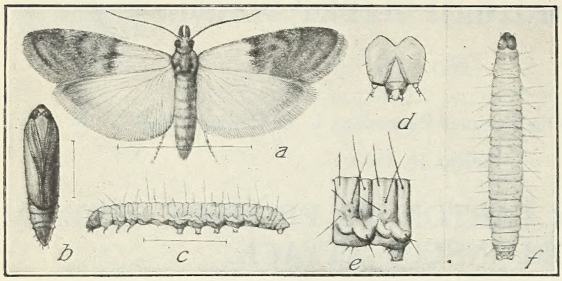

FIG. 1.—The Indian-meal moth (*Plodia interpunctella*): *a*, Moth; *b*, pupa; *c*, larva; *f*, same, dorsal view; *d*, head, and *e*, first abdominal segment of larva. *f*, Somewhat enlarged; *d*, *e*, more enlarged. (After Chittenden.)

INSECTS CONCERNED.

There are several insects which attack stored cereal products. Among the more important are the Indian-meal moth (*Plodia interpunctella* Hübn.) (fig. 1), the Mediterranean flour moth (*Ephestia kuehniella* Zell.) (fig. 2), the meal snout-moth (*Pyralis farinalis* L.), the saw-toothed grain beetle (*Silvanus surinamensis* L.), the confused flour beetle (*Tribolium confusum* Duv.) (fig. 3), the granary weevil (*Calandra granaria* L.), and the rice weevil (*Calandra oryza* L.). These are the principal insects which are likely to infest packed cereals.

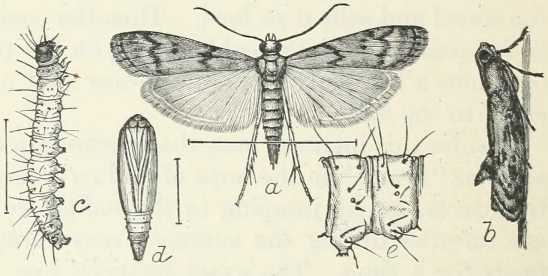

FIG. 2.—The Mediterranean flour moth (*Ephestia kuehniella*): *a*, Moth; *b*, same from side, resting; *c*, larva; *d*, pupa; *e*, abdominal segments of larva. *a*–*d*, Enlarged; *e*, more enlarged. (After Chittenden.)

There is an erroneous opinion with some people that the cereals become infested by spontaneous generation. This, however, is impossible; and when any insects are found in packages it is because the eggs, larvæ, or adults have gained access to the cereal after it has been sterilized.

EXPERIMENTS IN CALIFORNIA.

Using the foregoing observations as a basis, the following experiments were conducted, the idea being to test the efficiency of a cheap sealed carton.

A cereal was sterilized to such an extent that when it was placed in a package the temperature developed was 180° F. The packages themselves were sterilized before being filled, but had there been any

insects or eggs in them the heat from the cereal would undoubtedly have killed them.

When the ends of the packages were being fastened, the glue was not placed near the corners, so that if it were possible to leave an opening there by accident, the opening would be left in this experiment. All of the packages were regularly closed by gluing the ends, but some of them were covered by a piece of label paper (fig. 7) so that there were no openings where an insect could enter without piercing the label. Some of the labels were put on with glue and some with flour paste.

Eighteen of these packages, nine labeled and nine not labeled, were distributed in two wooden boxes. Between them flour and meal that

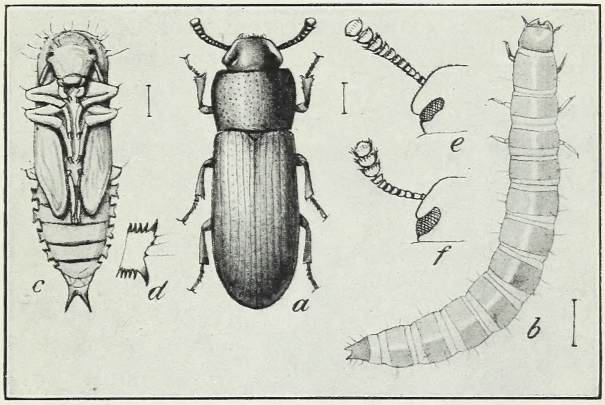

FIG. 3.—The confused flour beetle (*Tribolium confusum*): *a*, Beetle; *b*, larva; *c*, pupa; *d*, lateral lobe of abdomen of pupa; *e*, head of beetle, showing antenna; *f*, same of *T. ferrugineum*. *a–c*, Much enlarged; *d–f*, more enlarged. (After Chittenden.)

were badly infested by the confused flour beetle, the saw-toothed grain beetle, and the Mediterranean flour moth were packed. This infestation of the boxes was very carefully done, and when the experiment was observed on November 10, 1912, the outsides of all of the packages were literally alive with insects. The condition of the contents of eight of them is recorded in Table I.

TABLE I.—*Recorded conditions of infestation or noninfestation found in packages of cereal opened Nov. 10, 1912.*

No. of package.	Not labeled.	Label pasted.	Label glued.
1	Infested, containing web and adults		
2	....do		
3	....do		
4	....do		
5		No infestation	
6		....do	
7			No infestation.
8			Do.

A similar observation was made on January 24, 1913, the results of which are shown in Table II.

TABLE II.—*Conditions of infestation or noninfestation of 10 packages of cereal left until Jan. 24, 1913.*

No. of package.	Not labeled.	Label pasted.	Label glued.
9	Infested, containing web and adults		
10	do		
11	do		
12	do		
13	do		
14		No infestation	
15		do	
16			No infestation.
17			Do.
18			Do.

The results of this experiment seem very conclusive. Figure 4 shows the relative infestation on the outside and inside of the labeled and nonlabeled packages. These packages were all placed under the same conditions and given every chance to become infested.

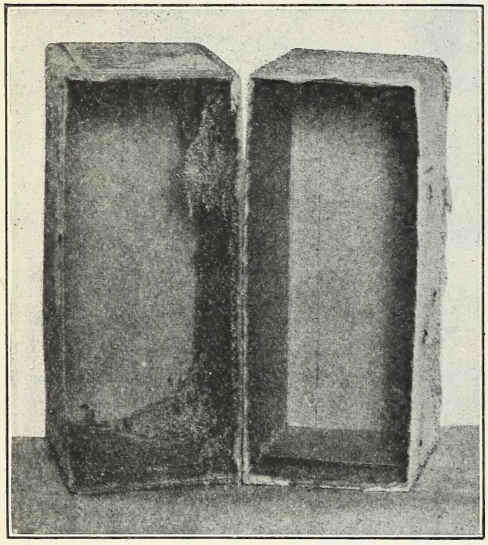

FIG. 4.—Results of experiments with cartons. The one on the left shows severe infestation; the one on the right had a thin label pasted on the outside and is not infested. The webs and adults of the infesting insects are shown on the outside of both cartons. (Original.)

The thorough infestation of nonlabeled packages and the absence of infestation in the labeled packages clearly indicate the efficiency of the label in preventing the insects from entering the cartons.

These experiments do not prove that insects are incapable of boring into the carton, thus infesting the cereal, but they do prove that when placed in regions of severe infestation the ordinary paper carton will become infested while the sealed carton will not.

WHERE INFESTATION TAKES PLACE.

In the process of sterilization the cereal is heated to a sufficiently high temperature to cause the death of all insect life, but following this process there are several ways in which it may become infested.

While on an elevator (see fig. 5) the cereal may be infested by eggs, larvæ, or adults of the several insects dropping or crawling into it. Warehouses are usually more or less infested by insects which crawl around on the packages. The grocer's storeroom and shelves are also

places where infestation takes place. Unless put into insect-proof carton the cereal, therefore, is subject to infestation from the

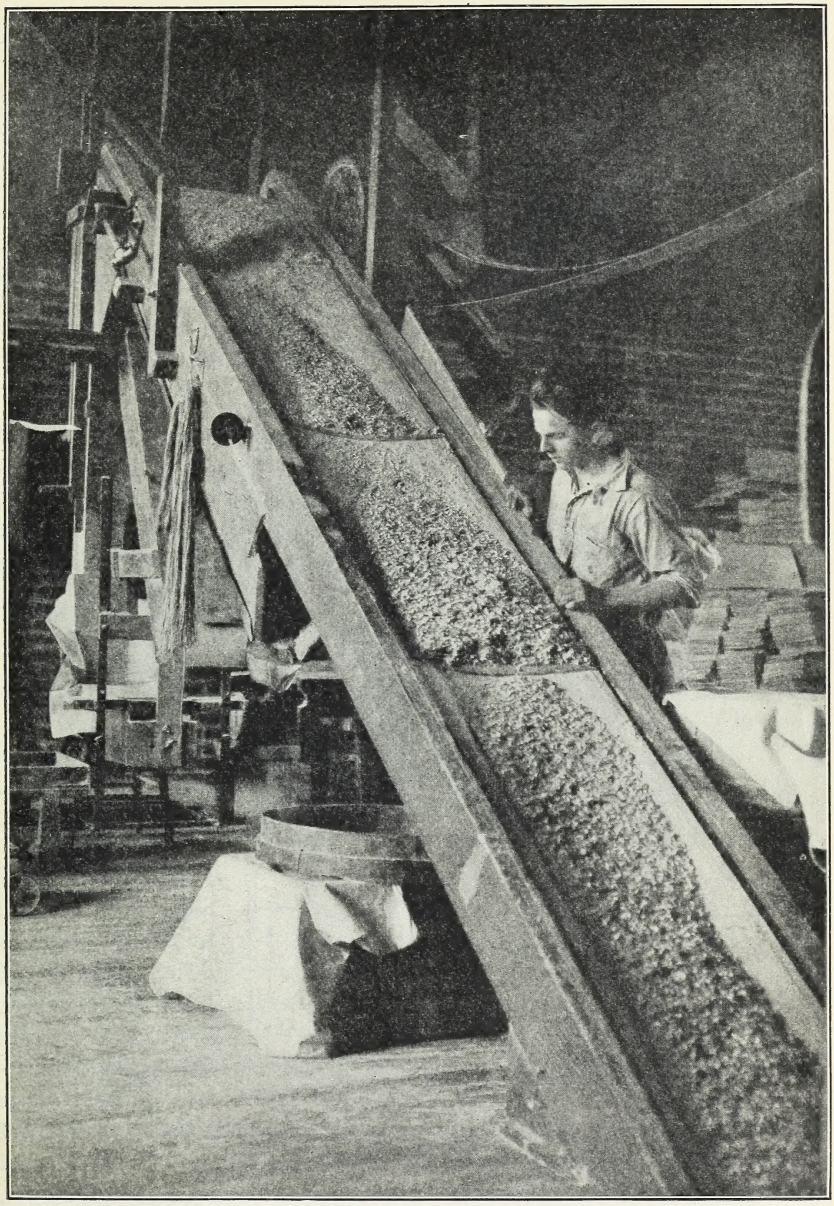

FIG. 5.—Cereal elevator which leads from sterilizer to packing room. Infestation may easily take place here. (Original.)

time it comes from the rolls or the sterilizer until it is sold to the consumer. Infestation may, of course, take place after the package

is opened by the purchaser, but this does not concern the manufacturer.

DRYING THE CEREAL.

After the cereal has been sterilized it may contain too much moisture to be packed, and a drying process then becomes necessary. In the case of cereals which are not flaky and to which agitation is not injurious, a sterile chute with baffles (fig. 6), through which hot,

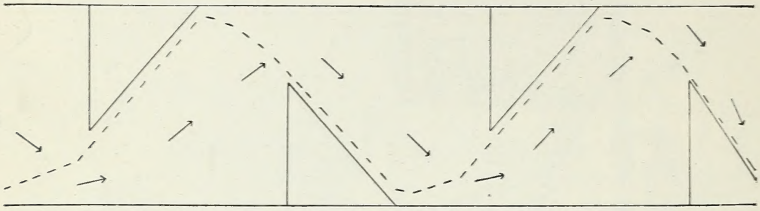

FIG. 6.—Diagram of chute with baffles for cooling cereal. (Original.)

dry air is blown, would be effective. The air is thus placed in contact with the falling cereal. In the case of flaky cereals a belt elevator is necessary, but this can be inclosed and the hot air used as in the former case. Both elevators should be so constructed that they can be readily sterilized with air at a temperature above 180° F. This should be occasionally done as precaution against infestation.

THE SEALED CARTON.

The sealed carton may be made of a stiff, though perhaps a cheaper, grade of cardboard than is used when the cardboard itself is printed. The printed label should be made in three pieces, namely, two ends, which lap over the edges and extend a short distance down the side; and a side piece, which securely covers the edges of the end pieces. (See fig. 7.) One sealed carton was observed which had a strip of paper pasted across the corners before the ends were put on. This further insures the resistance of the carton to insect attack and is advisable, provided the cost is not too great.

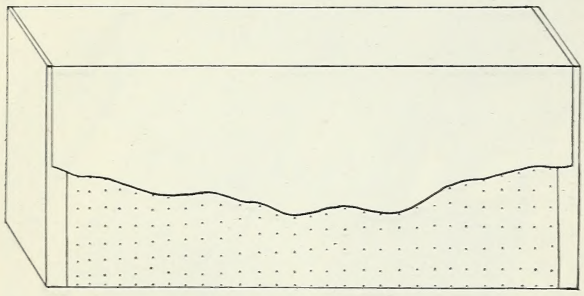

FIG. 7.—Diagram of carton, showing method of applying label to protect inclosed cereal from insect attack. (Original.)

A sealed package was observed on which the ends of the carton were not as firmly glued as they would have been had the package

not been labeled. The looseness of this end caused a break in the label, which, of course, ruined the seal of the package. Care in the proper sealing of the ends of the carton before applying the label will remedy this defect.

The extra cost of a sealed package over the ordinary one will vary with the labor or machinery available and the cost of materials. It has been estimated at 1 cent for a 2-pound package, but it is best determined by each miller for his particular locality. With right management the cost should not prove excessive, while the use of the well-made sealed package will minimize the chance of infestation. The improved appearance of such a package, also, renders it more attractive to the prospective buyer.

PACKAGES OTHER THAN SEALED CARTONS.

Other forms of packages have been suggested, the most promising one being a sealed paper bag placed inside of an ordinary carton.

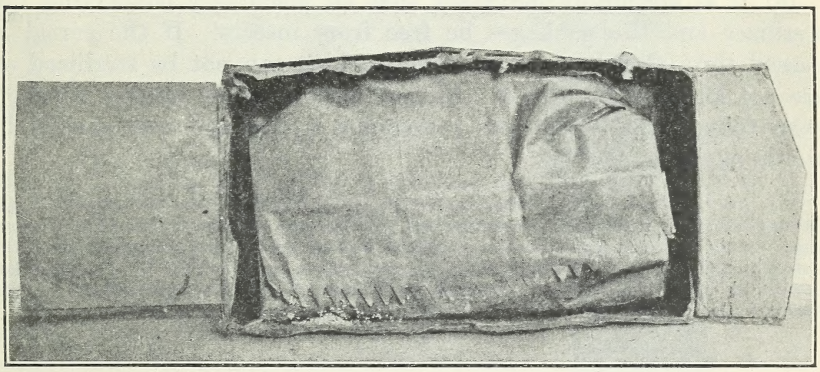

FIG. 8.—Carton with paper bag inside. Note larva on cover, and loose cereal which it has webbed together. (Original.)

Although this forms a barrier to insects which have crawled through the openings in the corners of the carton, it places them with little or no food firmly against a thin wall of paper through which they would be very likely to force their way.

Furthermore, it was observed that the ends of the paper bags were not readily sealed; small openings were left in many cases. One firm using this package reported that about as many of this type were returned infested as of the old-style packages.

Again, the small amount of cereal spilled between the bag and the carton is used by a larva, as shown in figure 8, and, in any event, the presence of insects on the top of the bag would be sufficient cause for the return of the package.

SUMMARY.

The foregoing observations and experiments have brought out several points:

(1) Cereals may become infested before they are packed, after the packages are placed in warehouses, and in the grocery stores.

(2) Insects find their way in at the small holes which are usually present at the corners of unsealed packages or at holes accidentally punched in the sides.

(3) Thorough sterilization[1] at 180° F. kills all insect life; and if the cereal is run from the sterilizer either through a sterile cooler or directly into sterile packages and immediately sealed, it will not become infested unless the package is broken.

(4) Sterilization of the knocked-down cartons before packing and cleanliness with regard to the exclusion of insects from the packing room will greatly facilitate the preparation of sterile packages and is strongly recommended.

(5) It is absolutely necessary that all machinery connecting the sterilizer and the packages be free from insects. If the cereal is passed through chutes or conveyors which can not be sterilized or are not kept sterile, it will, through these sources, become infested even though the cereal was previously sterile and was packed in sterile packages.

[1] The writer has not extensively investigated sterilizers, but the following description, furnished through the kindness of Mr. Bert D. Ingles, of a sterilizer used by a large flour mill in California may be of interest here. "In this sterilizer the screw conveyor is 6 inches in diameter and handles approximately 500 pounds of cereal per hour. The steam is held at 160 pounds pressure, which is equal to 370.5° F. A machine 8 feet long will heat the cereal under these conditions to 180° F. in two minutes without any difficulty. Such a sterilization does not injure the cereal."

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